FIFTH WATER INFORMATION SUMMIT: REGIONAL PERSPECTIVES ON WATER INFORMATION MANAGEMENT SYSTEMS

OCTOBER 23-25 WATERWEB CONSORTIUM , FORT LAUDERDALE, FLORIDA, USA 2002

DESIGN AND DEVELOPMENT OF A CANADA-WIDE WATER QUALITY DATA REFERENCING NETWORK

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ABSTRACT**:** This paper describes a Canada-wide water quality data referencing network currently under development as a result of the CCME (Canadian Council of Ministers of the Environment) Water Coordination Committee identifying the need for developing a national water quality data referencing network through the Internet. Currently, various database methodologies and computer networks are used by federal, provincial and territorial environmental agencies to provide access to surface, ground and drinking water quality data. This system adopts a nationally coherent and consistent approach for information access by departmental agencies having similar needs or interests. The data referencing network will not hold actual databases to avoid redundancy. Instead, it points the way to access various existing data by providing information about the data (i.e. meta data) such as where, when and how they were collected, who owns them and how to access and use them. Subsequent access to these databases by users is optional, and the databases are left in the control of the owners of the data. Key features of the system include data inventory, data access via distributed system, data analysis, online mapping, dynamic graphing, decision support/expert systems, and water quality indicator results. The system is based on a multi-tiered client-server architecture with web, database and

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map servers. It is believed the functionality and the ease of use of this system will serve a variety of users, ranging from novices or occasional users to sophisticated experts.
KEY TERMS: water quality; data referencing; web-based decision support system; online mapping

INTRODUCTION

The CCME Water Coordination Committee has recently identified the need for developing a strategic Canada-wide water quality data referencing network through the Internet. In Canada, different approaches in water quality database storage are used by the jurisdictions in the CCME, including various governments at the federal, provincial and territorial levels. It would require substantial effort to build a national water quality database from these heterogeneous databases. A better alternative is to develop a data referencing network. Instead of building a database with redundant data, a data referencing network provides mainly the information about the data, i.e. the meta data. Access to these databases may be provided through links to the appropriate partners, if the links exist, subject to their consent. Thus, at this stage of development, the Canada-wide water quality data referencing system will mainly deal with the meta data on the water quality databases from federal, provincial and territorial government agencies within the jurisdictions of the CCME. This project is currently funded by the Canadian Information System for Environment Secretariat as one of its nine pilot projects.

SYSTEM DESIGN AND STRUCTURE

The main goal at this stage of development of the Canada-wide water quality data referencing network (CWWDRN) is to incorporate the water quality inventory data provided by various federal, provincial and territorial partners. The data are stored in a database server such as MS-SQL server. The web server will query the meta data inventory and process the information based on the query, assemble the correct information, present the results in the a web page and return the resulting web page to the user. The presentation can be in the form of text, tables, graph, and/or map. Since environmental data often deals with geographical locations, online mapping can interact with the users with this user-friendly approach. Figure 1 shows the various query options and possible paths and Figure 2 illustrates the client/server structure that supports this design.

The CWWDRN development can be made in two stages. Stage 1 deals with the implementation of inventory information and meta-data. Stage 2 is to summarize, analyze, and integrate the information in a manner that will help the users understand the trends, water quality indices and other relevant results about the data themselves. The Stage 2 development will be designed with a decision support approach (Lam et al. 1997) for

better understanding of the data as well as for broader decision-making consultation processes. Both stages require effective visualization and analysis tools that can provide concise and accurate information on water quality to various users. The system will be developed jointly with participating partners to ensure that the results are useful for various end-users.

DATABASES

Water quality inventory data provided by the 13 jurisdictions under the CCME will be stored in the CWWDRN database. The 13 jurisdictions consist of the federal government, the ten provinces (British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Quebec, New Brunswick, Prince Edward Island, Newfoundland and Nova Scotia) and the three territories (Northwest Territories, Nunavut and Yukon). The CWWDRN database will therefore contain different levels of information about the water quality inventory information. Examples of information in the CWWDRN meta-data database include the project name, the name of the water body and its geographical location (latitude and longitude), the water quality parameters, sample frequency, sampling purpose and issue, and the key contact agency/person involved with the data.

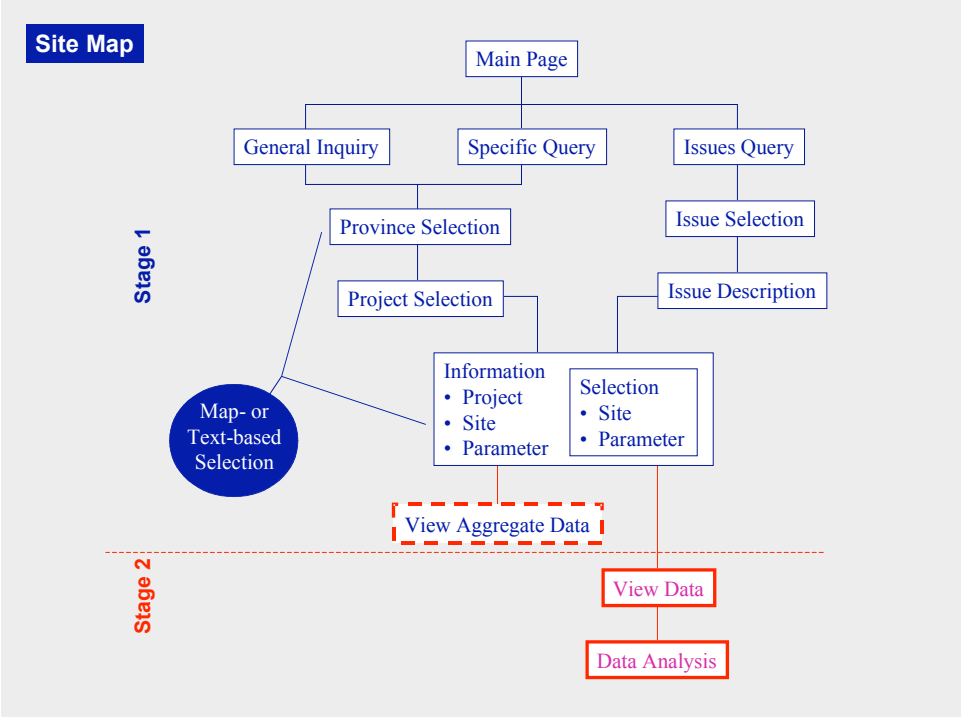

Figure 1. Query options and pathways

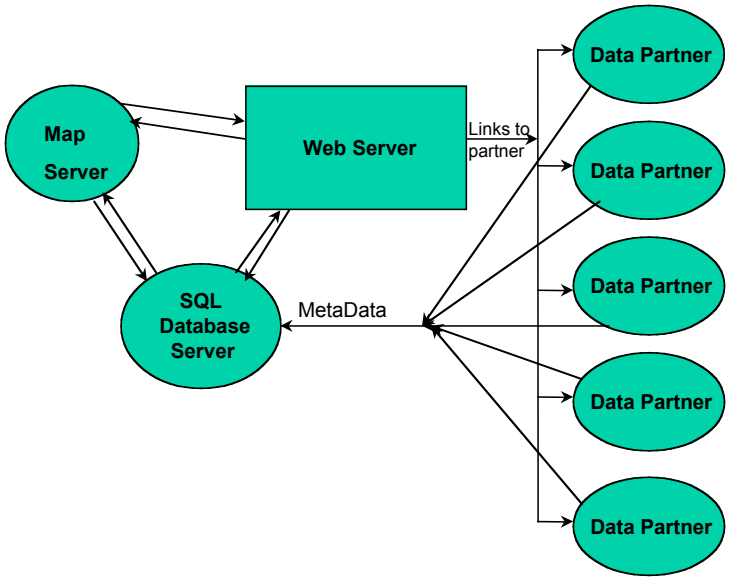

Figure 2. System structure.

WEB SITE DESIGN CONSIDERATIONS AND TECHNOLOGIES

Because the web site is intended for a wide spectrum of audiences, including technical and non-technical users, it is designed to have intuitive navigation for easy usage in the overall design. Also, since there are different needs for different levels of the users, the site will be eventually divided into three access levels: federal (intranet), province and territory (extranet) and general public (Internet). Depending on the access level, the system delivers appropriate information to the user. For example, eventually the provincial and territorial partners can access the system to keep their own information up-to-date. Figure 2 illustrates a possible configuration of the system for such communications.

To support this design, a variety of web technologies and software are required, including Internet security using HTTP username/password protection, Microsoft SQL™ Server, MapGuide™ Server, MS IIS™ Server, HTML, ASP, Java, JavaScript, VBScript and XML. It will comply with the web site design rules and regulations on *Common Look and Feel* provided by the federal government, as well as water quality meta-data standards adopted by participating partners.

AN EXAMPLE OF AN ACCESS SESSION

As an example, a simple web interface between the user (client) and the system (server) has been developed, allowing information search based on regions, water quality parameters (individual or group), sampling purpose and issue, and keywords. To illustrate some of the searching capabilities, we want to search all the projects that are related to, e.g., "*nutrients"*. As a start, Figure 3 illustrates the keyword search page using the word "*nutrients*". Figure 4 returns all the related water quality projects in the CWWDRN database that are associated with "nutrients". At this time, the user can access the information of a particular project. The detailed project information can be retrieved and the sampling stations can be displayed on a map (Figure 5). The user can retrieve further information at the station level by selecting the appropriate station interactively. The manipulation can then bring in the station information as shown in Figure 6.

Alternately, the user can retrieve data by choosing items, through pull-down menus, from the region list, the parameter list and/or the water uses list (Figure 7). The results will be retrieved based on the selection and is similar to the above example.

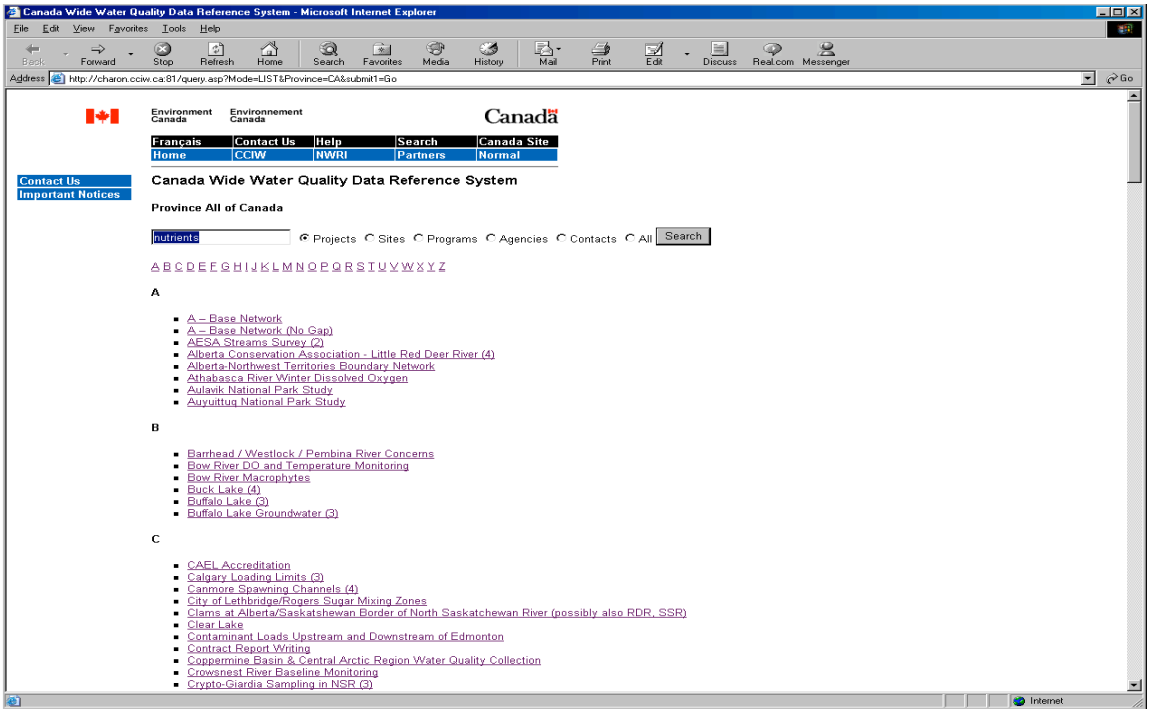

Figure 3. Keyword Search (searching for "nutrients")

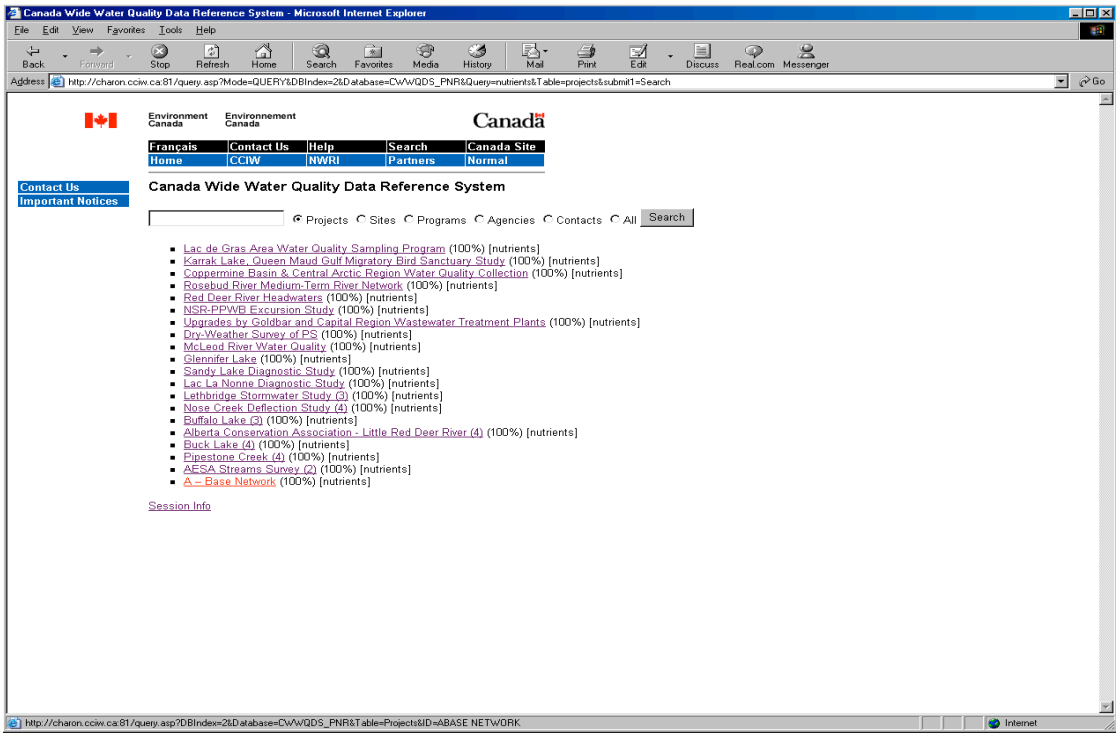

Figure 4. Projects that match the keyword (“nutrients”).

Figure 5. Detailed description of the selected project.

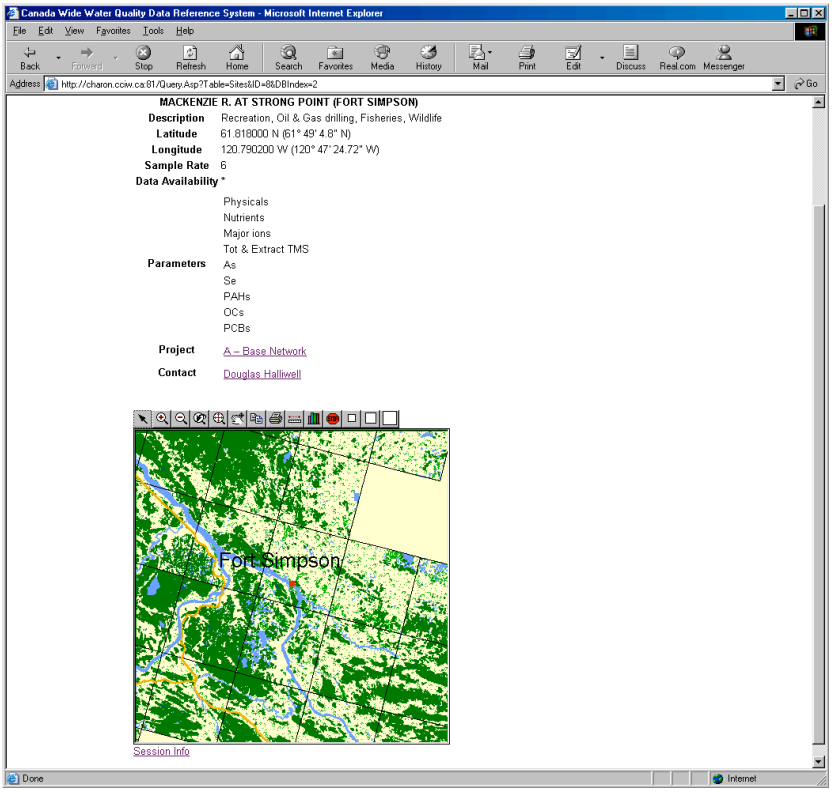

Figure 6: Detailed description of a sample station for the selected project.

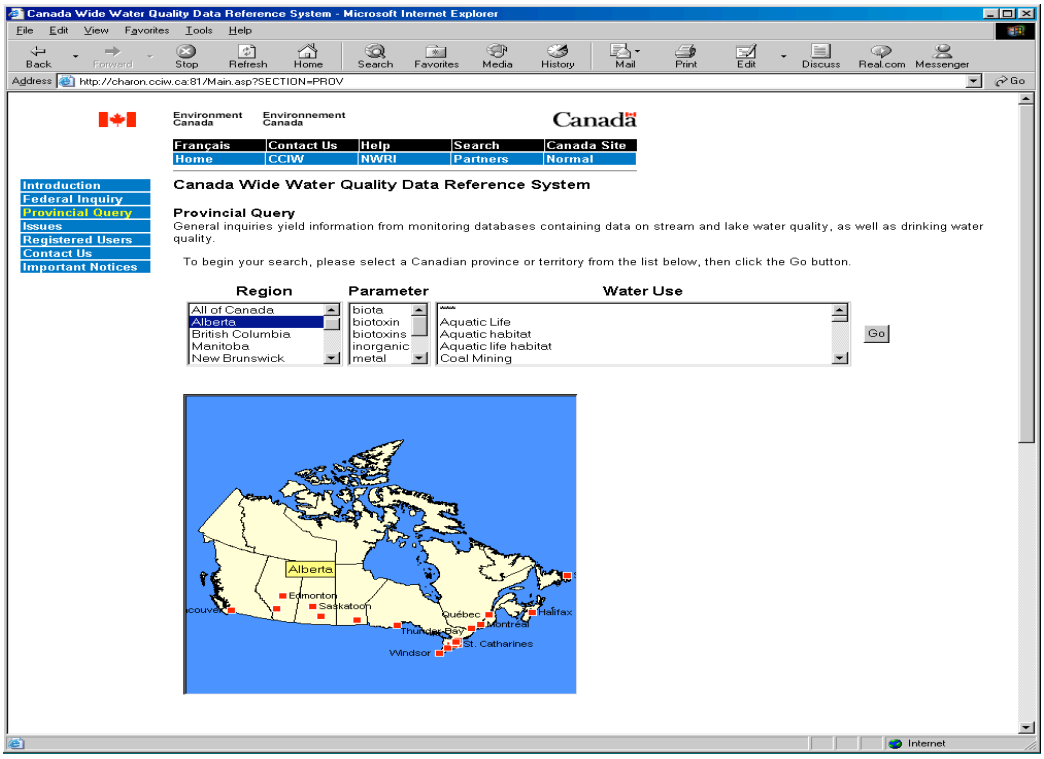

Figure 7. Data Retrieval Selection Boxe

STATUS OF IMPLEMENTATION

Stage 1 is currently in development and will be launched in the spring of 2003. Planning for Stage 2 is already underway and includes an automatic database maintenance system for the water quality data inventory, data access to partners database for summary data, decision support and expert system/modelling tools such as water quality indicators and trends. More interactive online mapping and dynamic graphing functionality are to be provided in future versions, depending on feedback from participating partners and users.

CONCLUSIONS

The Canada-wide water quality data referencing network is a necessary approach to multiple, heterogeneous databases from various jurisdictions and agencies. Advances in the Internet technology now help make this system a reality. Users can access the system at their own levels and information is provided with rich visualization tools, online mapping and dynamic graphing capabilities to help distribute the information about water quality data from these agencies.

ACKNOWLEDGEMENTS

The funding support from the Canadian Information System for Environment (CISE) Secretariat and the assistance from the CISE cross-cutting theme team and other pilot projects are gratefully acknowledged. The authors also thank the contributions, advice and support from participating partners from the 13 jurisdictions and the Water Coordination Committee of the CCME. They are grateful for the help and advice from Ken Brown, Alex Storey, Catherine Chen, Janine Murray, Scott Painter, Reg Dunkley, Geoff Howell, Sarah Hall and many other colleagues during this design and development phase. The authors also thank the support and encouragement from Karen Lloyd, John Carey, John Lawrence, Fred Wrona and Alex Bielak at Environment Canada.

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